Dynamic behavior, empiric modelling and tuning of PID controllers through Research-Based Learning applied to level, temperature, and flow control

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Abstract

Research-Based Learning (RBL) intends to bring research closer to the teaching-learning process, promoting the processes of reflection, inquiry, data analysis, capacity for self-criticism and knowledge generation. In this work Teaching Based on Guided Research [1] is used as an active methodology in the subject of Chemical Process Control in the Chemical Engineering Degree to engage students in a research project conducted through a scientific research approach [2].

Experimental temperature, level, and flow LD Didactic control panels (Prodel) are used as representative of the common process variables whose control is usually covered in process control undergraduate courses.

The panels integrate all elements of a feedback control loop: sensor-transmitter, PID controller and actuator. The signal, in volts, flowing trough the control loop in the panel is send to a computer, previous analog to digital conversion (or from the computer to the panel, previous digital to analog conversion) using a PCI data acquisition card. The GeniDAQ software (Advatech Co., Ltd.), with visual programming language, coupled with Excel, allows to monitor, register, analyze and fit to empirical dynamic models the signals from the panel (Fig. 1). The conexion and programming of data adquisition between the panel and the computer is built by the student, working at the same time with the complementary area of signal transmission.

The student is guided to investigate the effect of each variable on the corresponding controlled process variable (temperature, level or flow), and to analyze the dynamic behavior in open loop. The mathematical dynamic modelling is applied to the experimental data from the panel allowing the student to understand key concepts of process control (such as gain, time constant, dead time, first and second order behavior, linearity and stability). The parameters from the empirical models are used to calculate the optimal PID control tuning parameters. These parameters are implemented in the panel and the student compares the different tuning methods such as Ziegler Nichols, CHR (Chien, Hrones and Reswick) or IAE (Integral Absolute Error), taking a decision based on the real behavior of the controlled panel and thus improving his/her knowledge and skills in chemical control process.

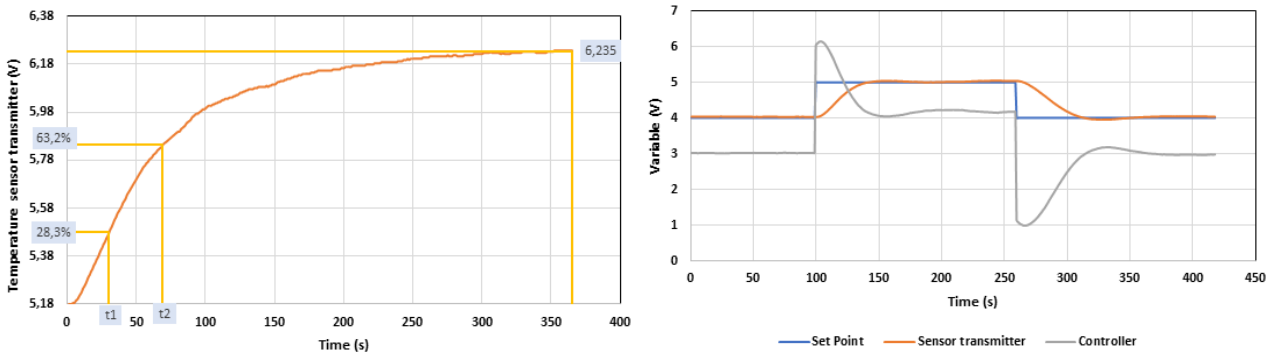

Figure 1. Dynamic behavior of temperature panel: open loop (left) and closed loop using IAE method (right).

References

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